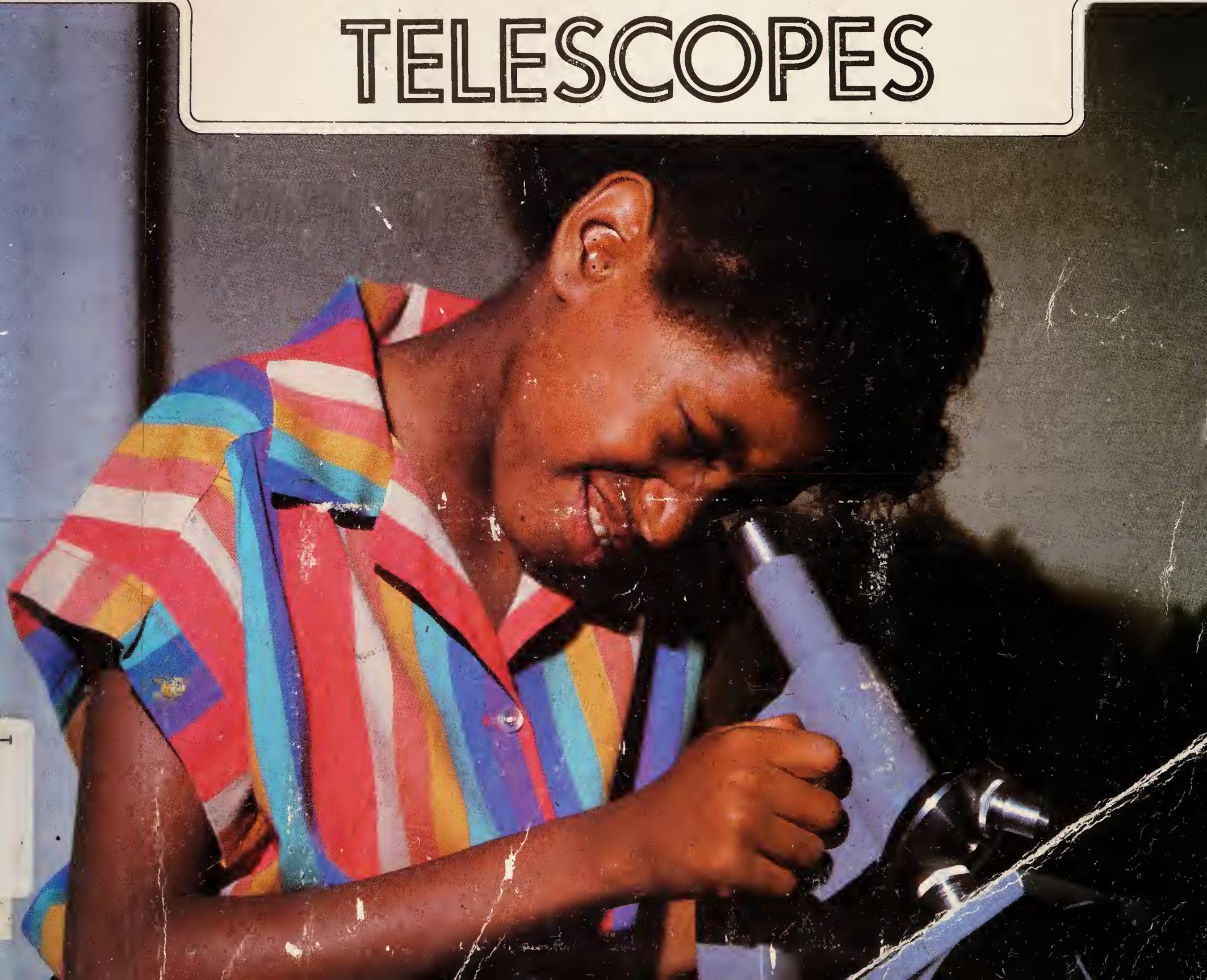


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A New True Book

MICROSCOPES AND TELESCOPES



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A New True Book

MICROSCOPES AND TELESCOPES

by Fred Wilkin, Ph. D.



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Group of objective lenses for a microscope

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Close-up of a microscope and slide.

After examining objects under a microscope, detailed drawings can be made. Then a model of a bee can be built with scientific accuracy.



MICROSCOPES AND TELESCOPES

With a microscope you can see small things and make them appear larger.

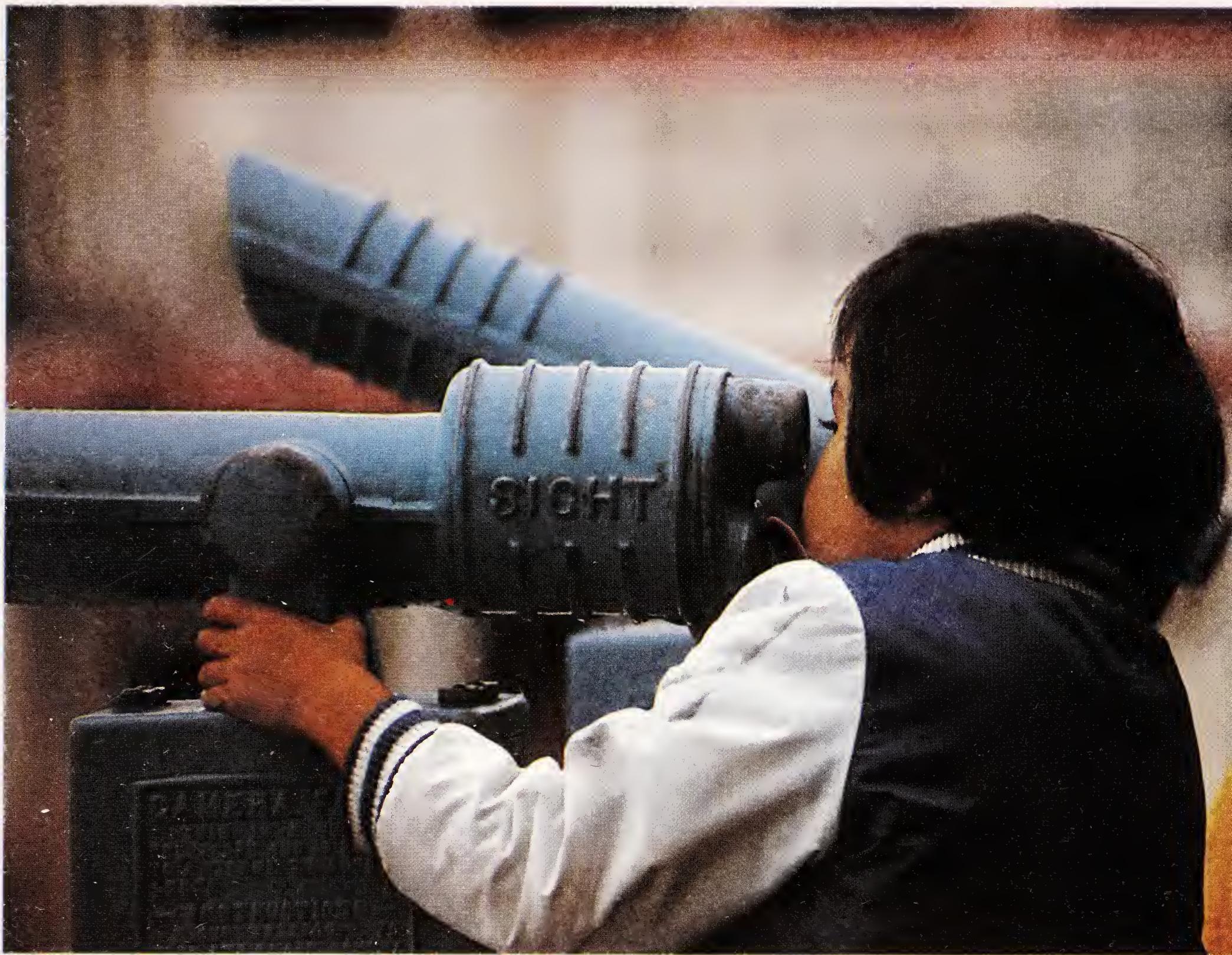
With a telescope you can see faraway things and make them appear larger.



With a telescope you see ships at sea.

Microscopes and telescopes are both kinds of scopes. A scope is an instrument used to see things. One meaning of scope is *to watch or to look at*. A scope is used to look at things.

Micro means very small.
To look at + small things
= a microscope.



Powerful telescopes bring objects at a distance closer.

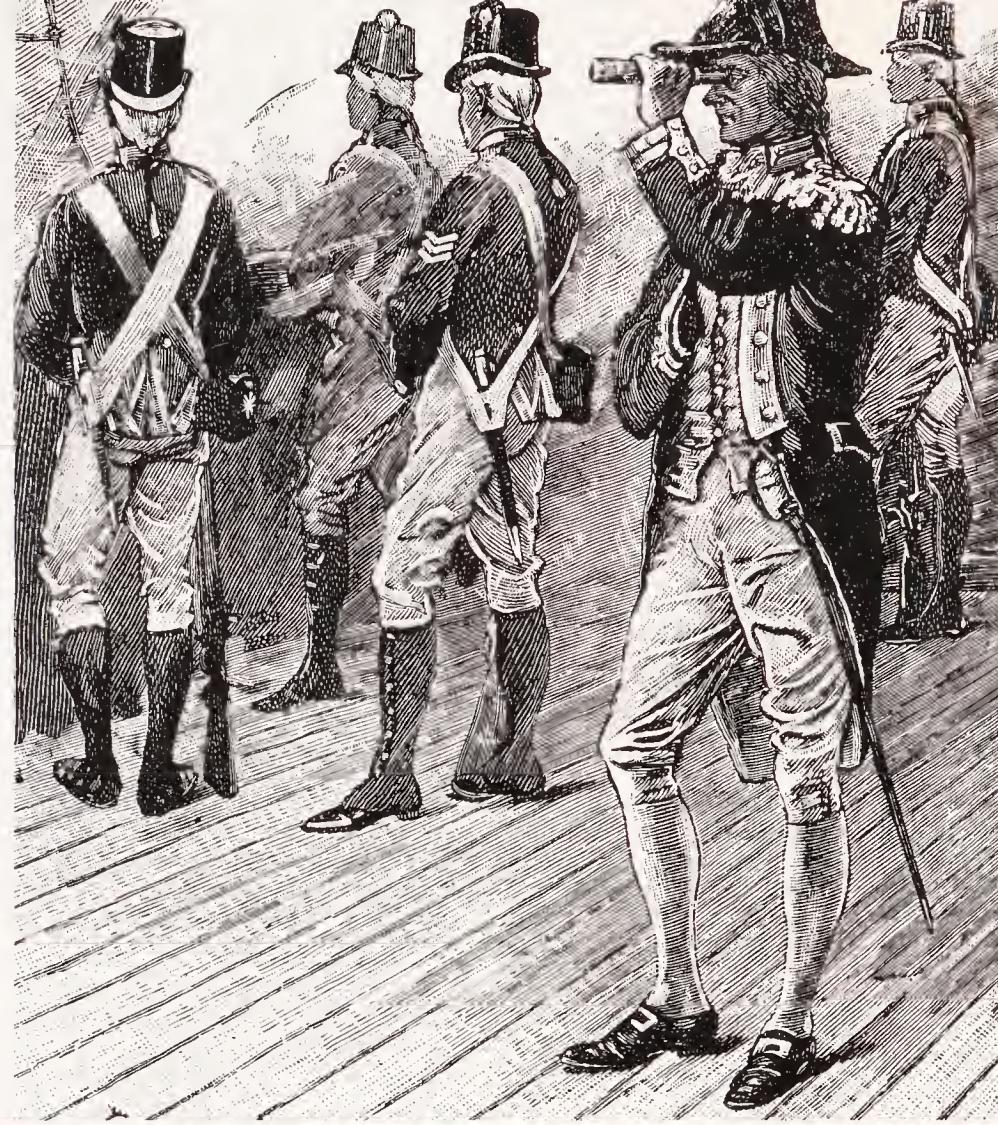
Tele means at a distance.
To watch + at a distance
= a telescope.

EARLY SCOPES

The thing we now call a telescope was once called a looker. Lookers were used for watching battles from a great distance.

It was safe to watch an army from far away, and not be in the middle of the fighting.

In 1608, Hans Lippershey, a maker of eyeglasses, invented the telescope, or looker.



Admiral Nelson (above) used a spyglass, or small telescope. The telescope was invented by a Dutch eyeglass maker named Hans Lippershey (left).

When the Italian scientist Galileo heard about this looker, he decided it could be used for looking at the sky. He would be able to observe the moon and the planets.

Galileo was an Italian astronomer and physicist.

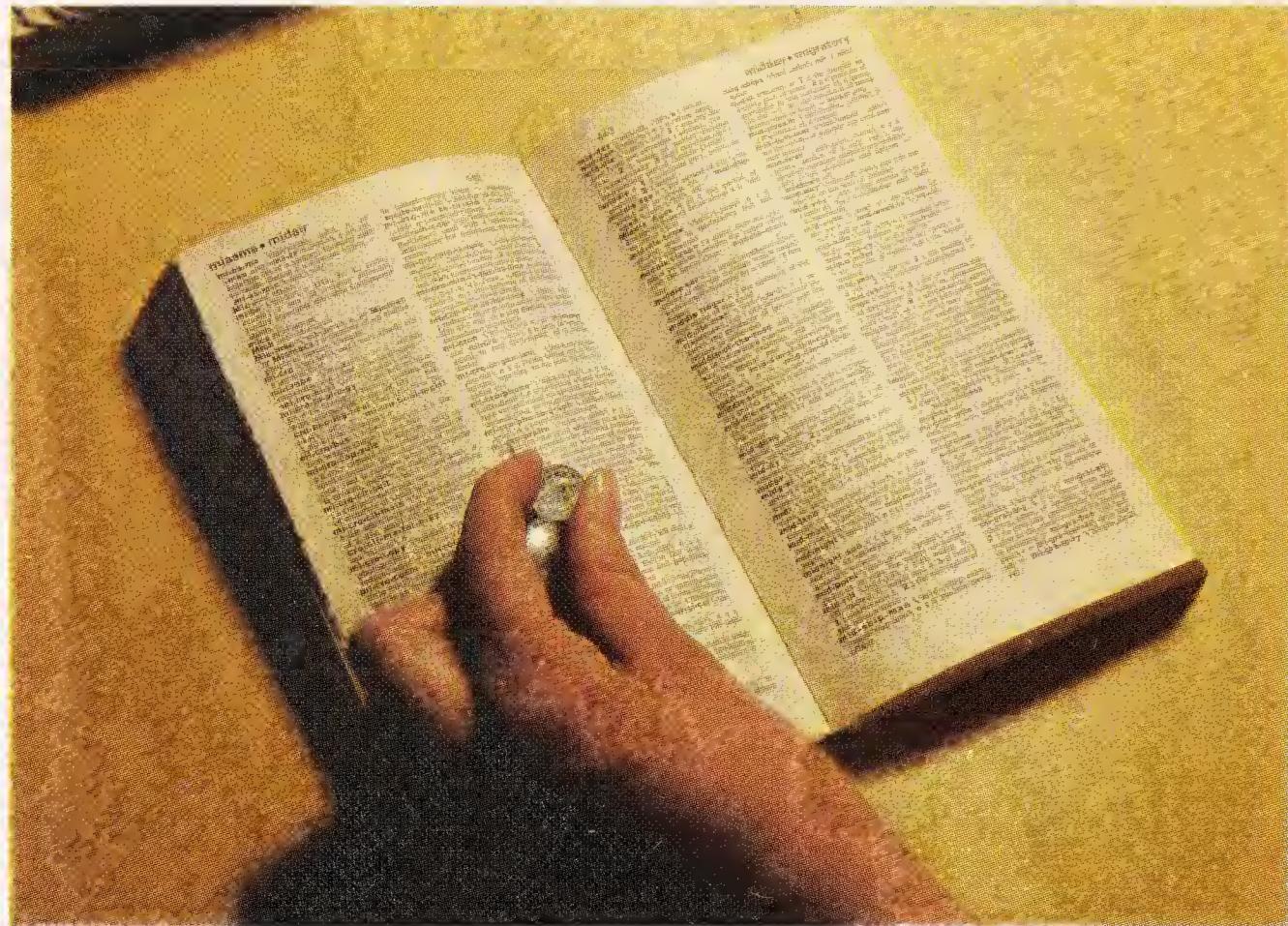


The telescopes that Galileo made and used were simple and not very powerful. However, they helped him and others see things in the sky that had never been seen before.

EARLY MAGNIFIERS

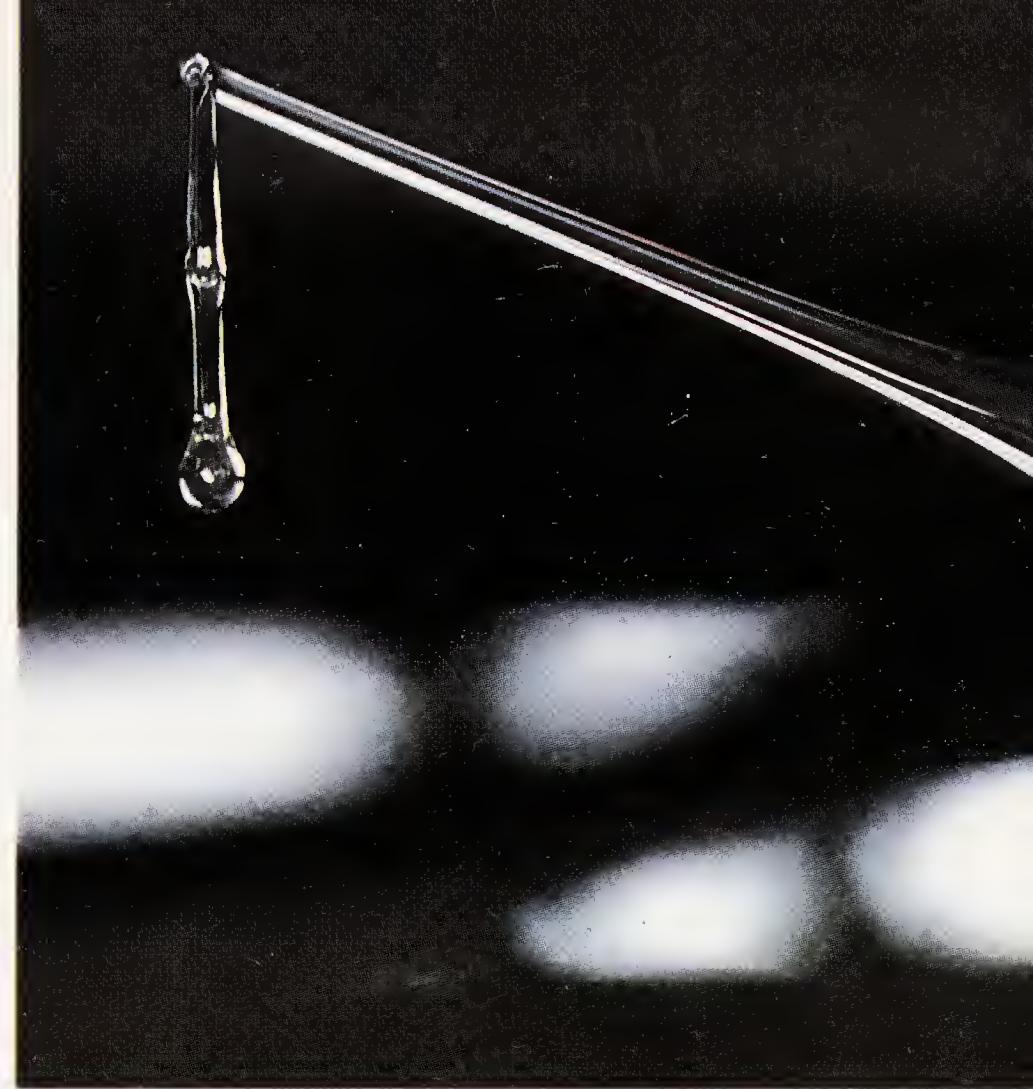
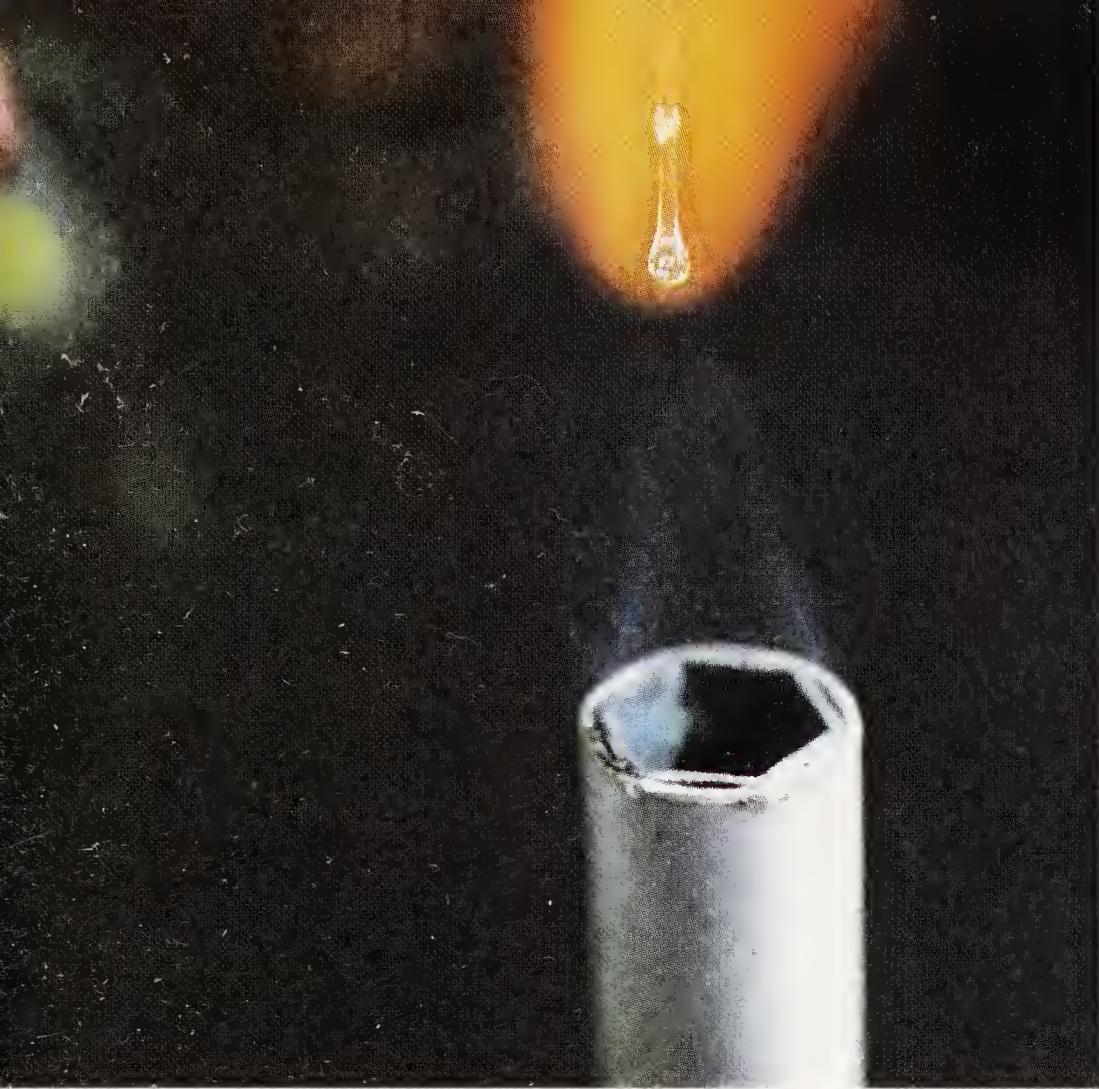
Long ago, it was seen that clear ball shapes would magnify. Round glass bottles filled with water acted as magnifiers. So did clear rounded shapes of solid glass. To look at small things and make them appear larger, put a clear glass marble on the print on this page.

A bead
lens will
magnify.



Other early microscopes used a bead of glass much like the shape of a drop of water. Today in some powerful microscopes the lens looks like a tiny bead.

A small beady lens of glass is made using heat.



Heat is used to make glass beads.

A thin glass rod is simply held in a hot flame. It begins to soften and melt to form a droplet of glass that is almost perfectly round and shiny and clear.

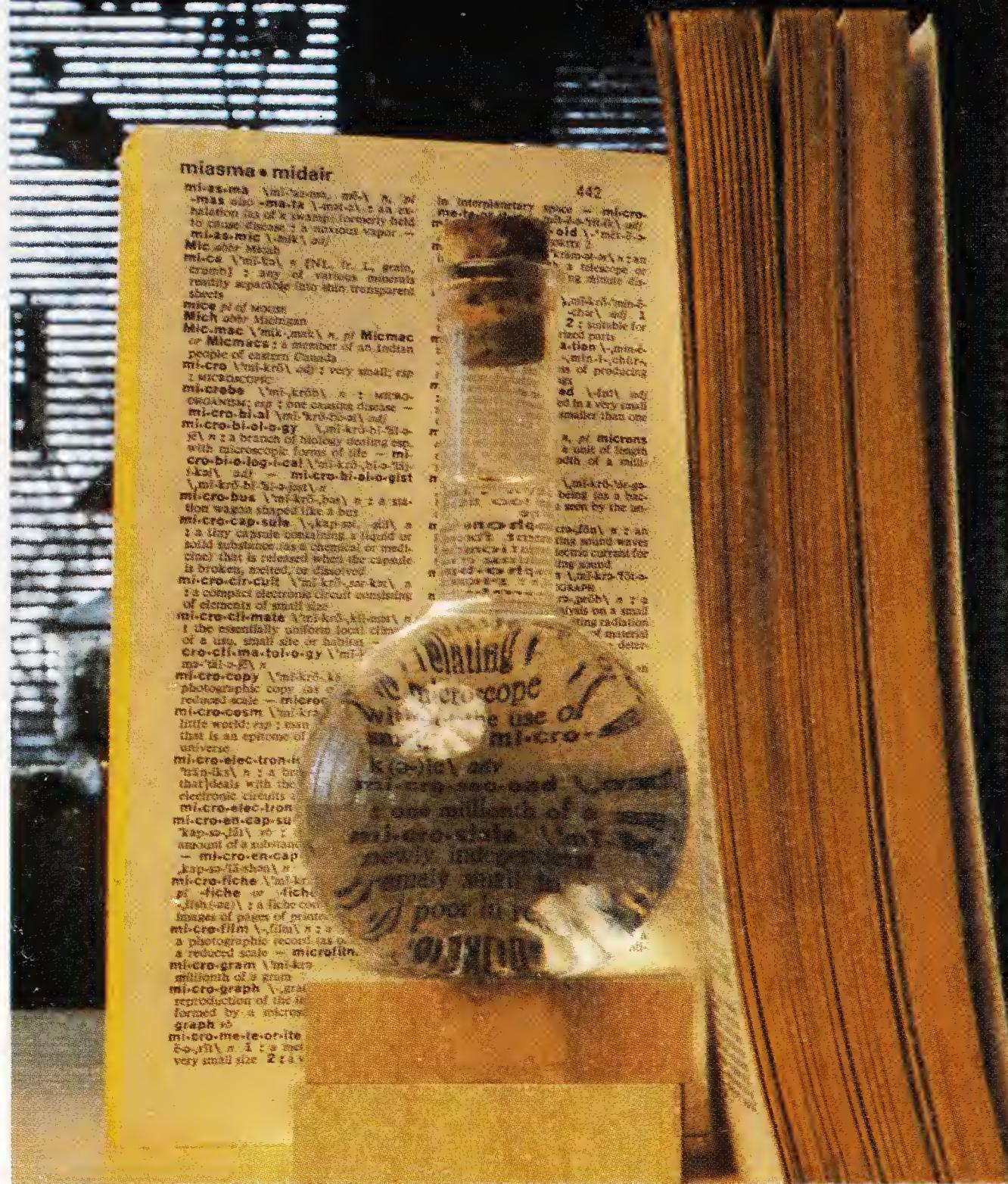
A simple microscope uses such a glass bead.

LENSES

A lens is used to focus light. It brings light to a point. Convex lenses are used in most scopes.

There is another type of lens called concave. It appears to be caved in. Concave lenses do not focus light into images. Convex lenses do.

A round glass water bottle can be a lens. It will focus fairly well. Light rays



Can you see
how the bottle
lens magnifies?

pass in through one
curved surface, then
through the water, and out
through a second curved
surface. In and out

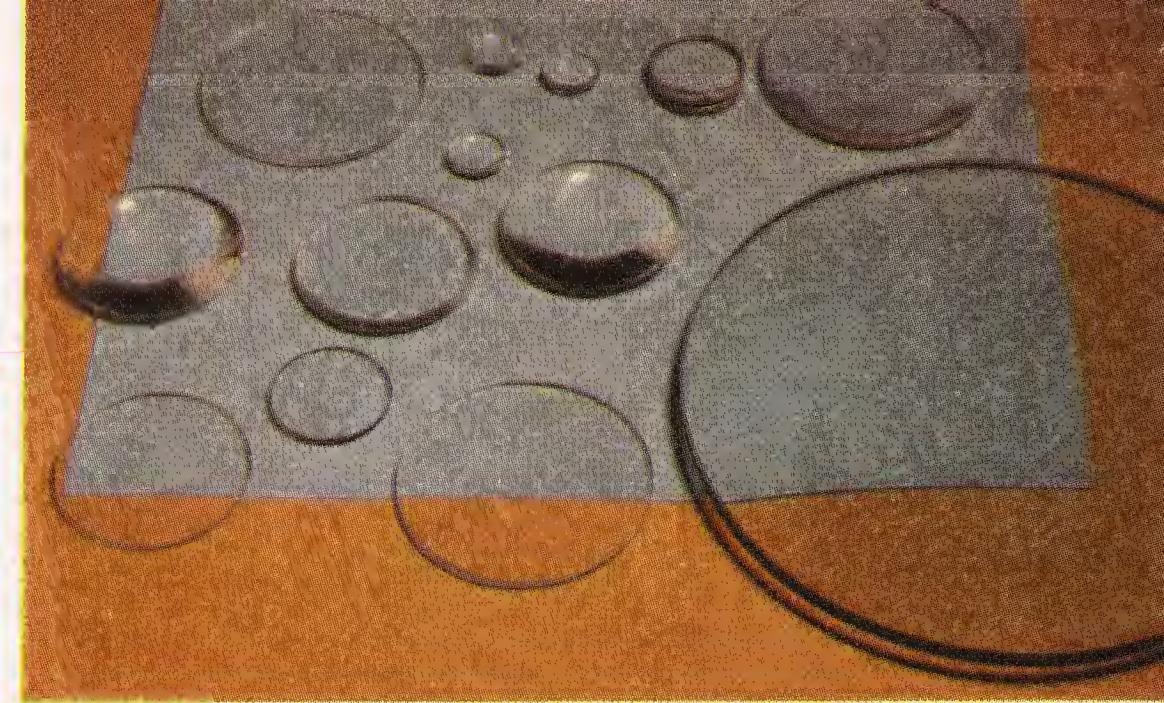


Concave lens (left) and convex lens (right)



of the surfaces, the light path changes direction.

Light rays passing through a curved clear substance are brought to a point. Looked at sideways, a convex lens is thick in the middle and thinner at the edges.



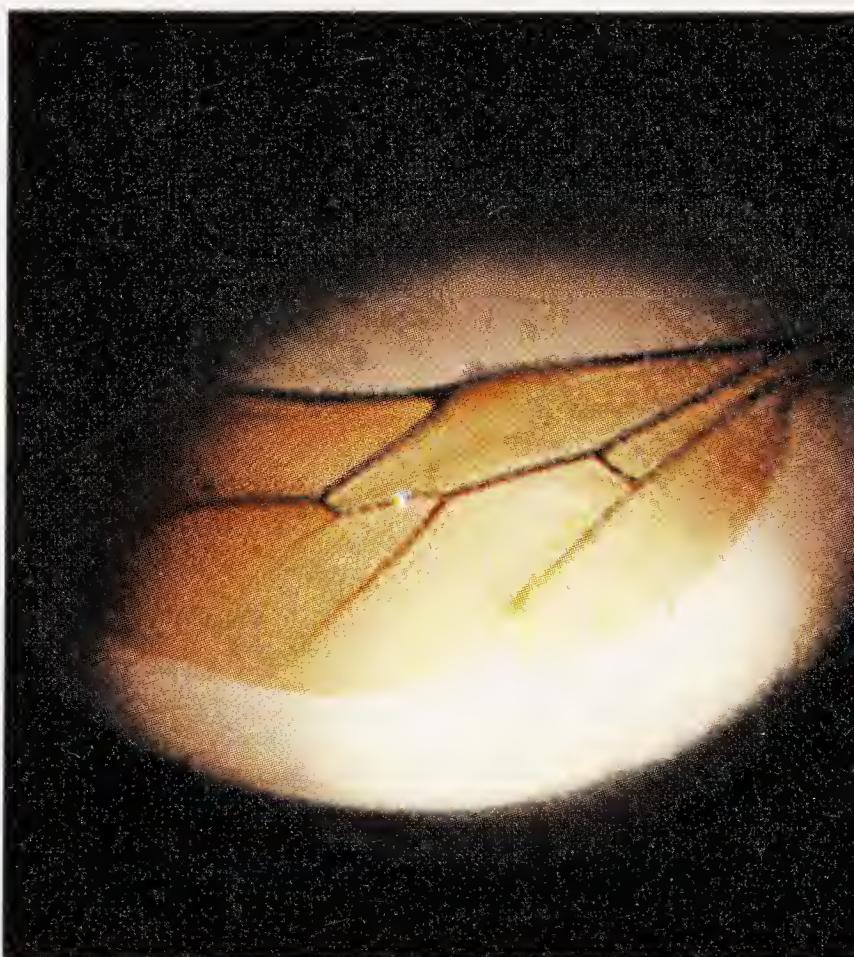
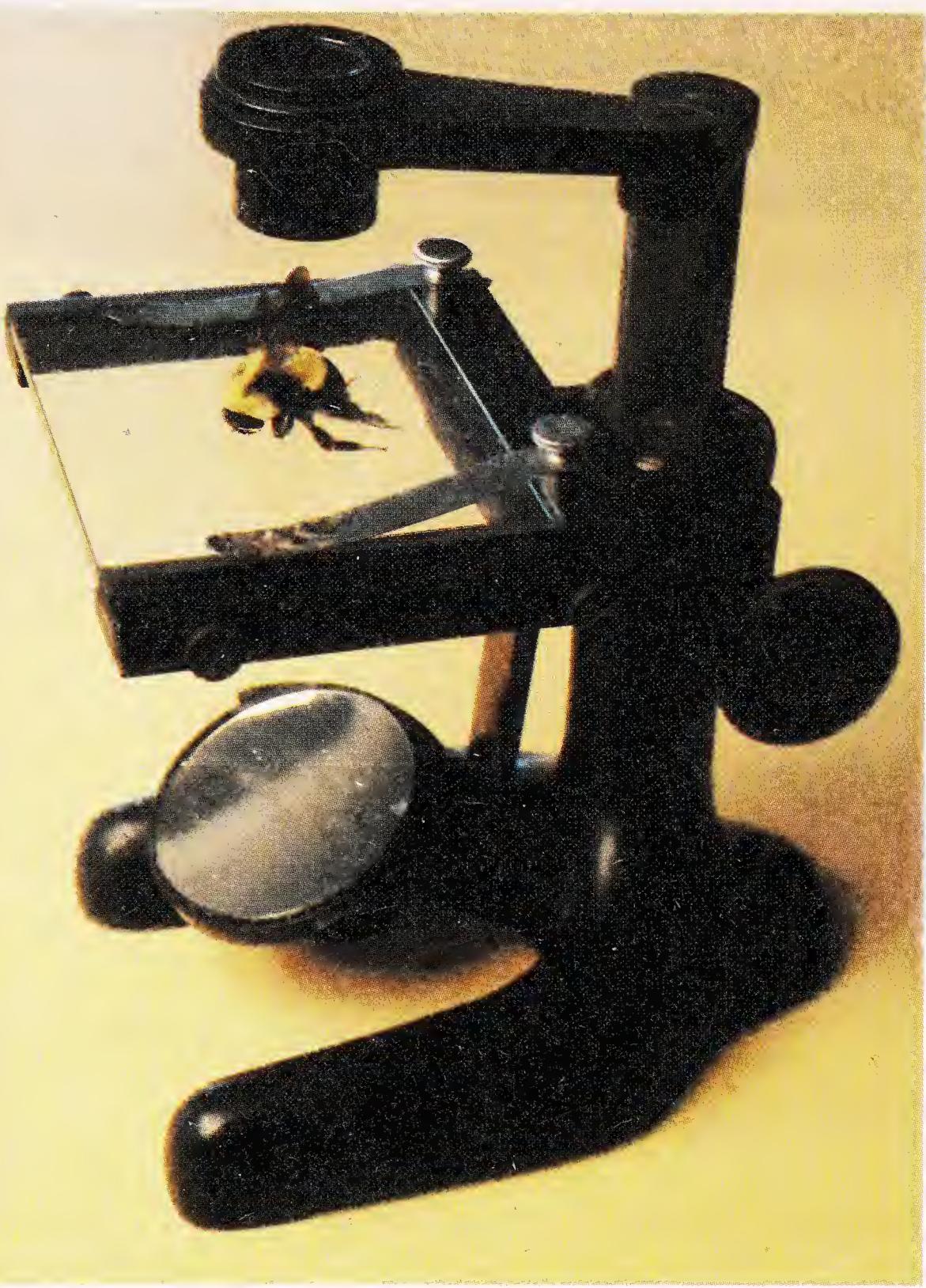
Concave lens (left) and convex lens (right). Convex lenses (above) come in many sizes and have different curvatures.

Convex lenses can be small or large in diameter. However, there is another difference that is more important. Lenses differ in the curvature of their surfaces. Some are rounded. Some are almost flat, with very little curvature.

SINGLE LENS MICROSCOPES

A single short-focus lens is the main part of this microscope. The lens is supported by a holder that moves. The lens can be adjusted up and down. The knob and a gear move the lens for focusing.

Light from the sun or a lamp shines on the object, or specimen. Light



This microscope (left) uses a mirror to reflect more light on a bee specimen. Under a microscope a bee's wing (above) reveals many details not visible to the naked eye.

can also be reflected from below by the mirror to put more light on the specimen.

The microscope keeps things steady and in focus once it is adjusted. You have a free hand for drawing what you see.

With a microscope, you can begin to see the fine details of all kinds of materials and things.

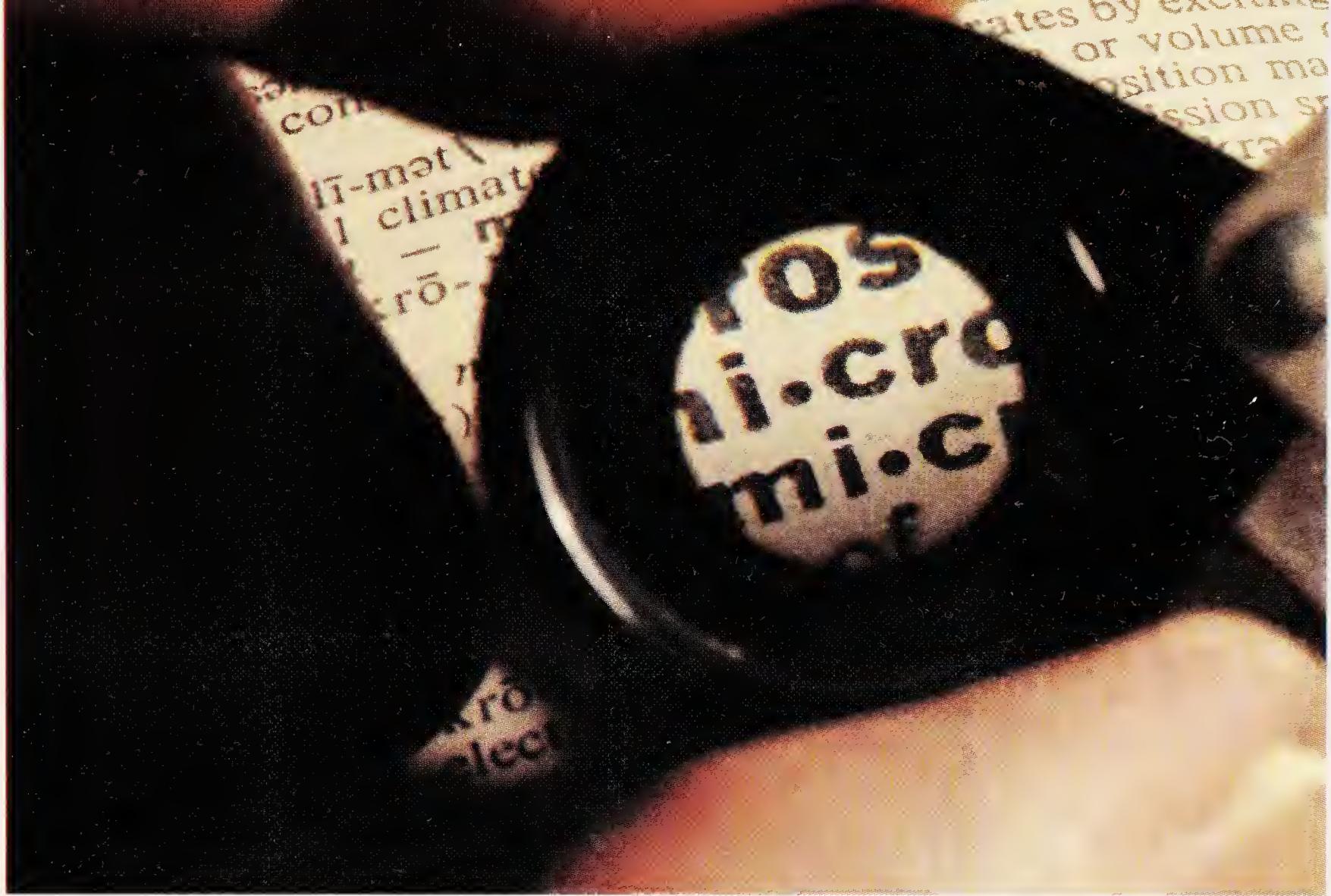
Some kinds of single lens hand microscopes are small. With a glass slide clipped into place and a specimen on it to view,



Pocket microscope (left), a pencil microscope and salt specimen (right)

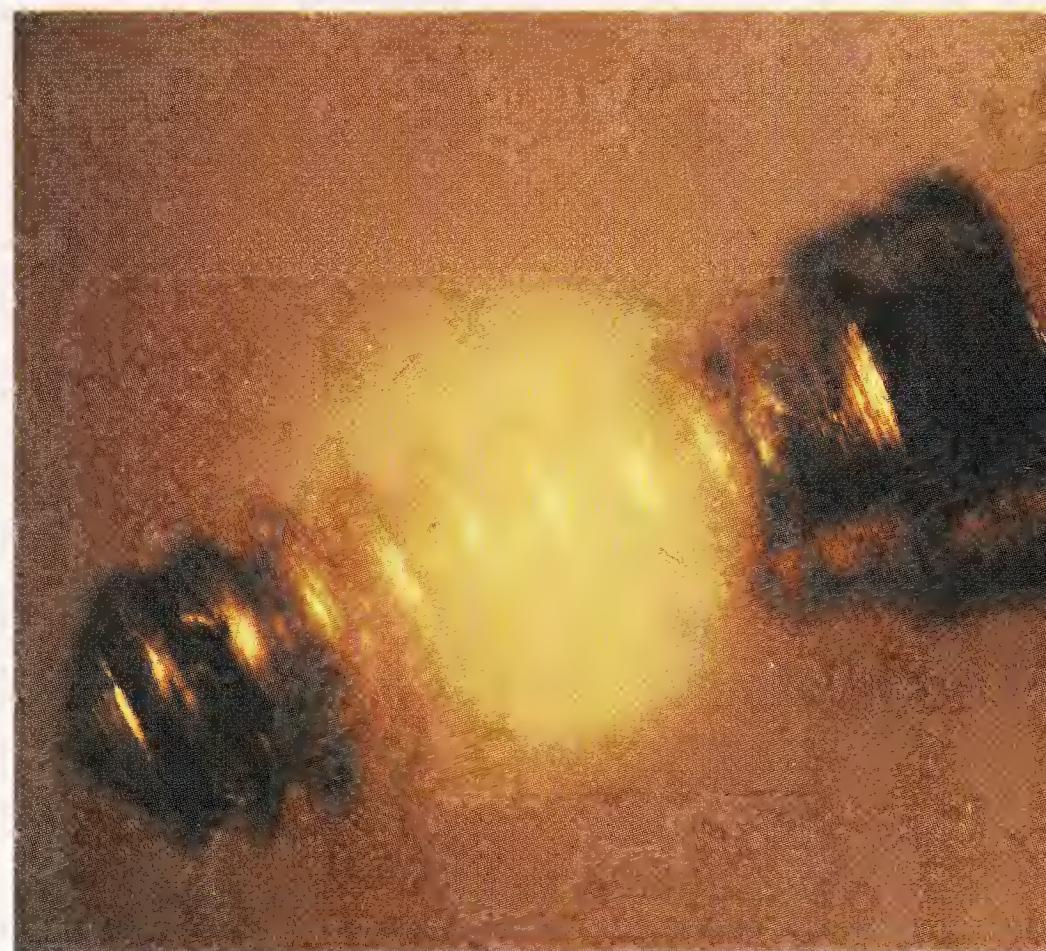
this little microscope provides fifty times magnification. It is useful on field trips.

A pencil microscope does a good job of magnifying tiny objects like sand and salt grains when held close to them.



Simple hand lens

The “scope” of microscopes could include simple hand lenses. Easy to carry and use, they help a keen observer who wants to see many things.



Magnified eyeglass screw (above) and the workings of a pocket watch (left)

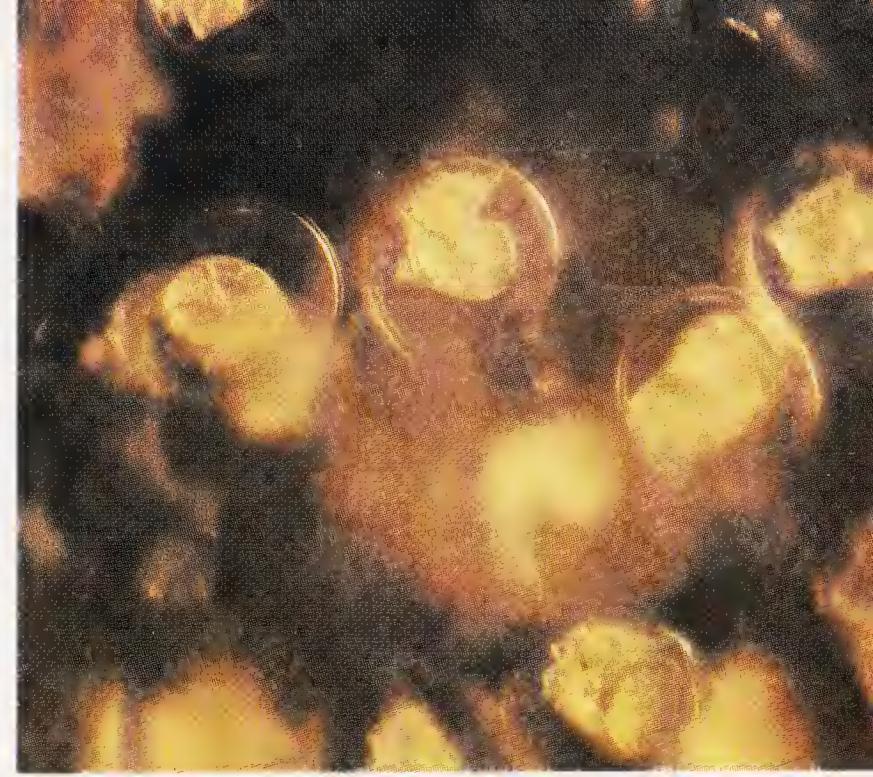
For example, here is an eyeglass screw. Have you seen the inside workings of a pocket watch?



Barrel of scope used as lens.

LENSES AND A TUBE

This is the main part of an old microscope. It is a tube with lenses at both ends. It is bigger than the pencil microscope but works about the same way.



Microscopes can be used to study marine life, such as these magnified snail eggs (above).

The whole tube of this microscope acts like a thick, solid single lens. It can be used and held in this way to examine plant life in an aquarium or for watching a snail. It gives a close-up view of snail eggs.

Usually the tube is fitted into a slider on a heavy base called the foot. Then the tube with its lenses adjusts up and down with a knob and a gear.

The lens called the objective is the one brought close to the slide.

Put a bee wing onto the slide first. Then put the slide on the stage.

The barrel of the scope holds the lenses in position.



Close-up of an objective lens and slide

There are directions and rules for operating the microscope. There are skills to learn. It may be a sturdy machine, but in some ways it is delicate. Use it very carefully.

ADJUSTING A MICROSCOPE

Never turn the adjusting knob so that the barrel moves down while you are looking into the eyepiece.

Instead, look at the slide on the stage from the side. This way you can clearly see the distance between the objective lens and the specimen.



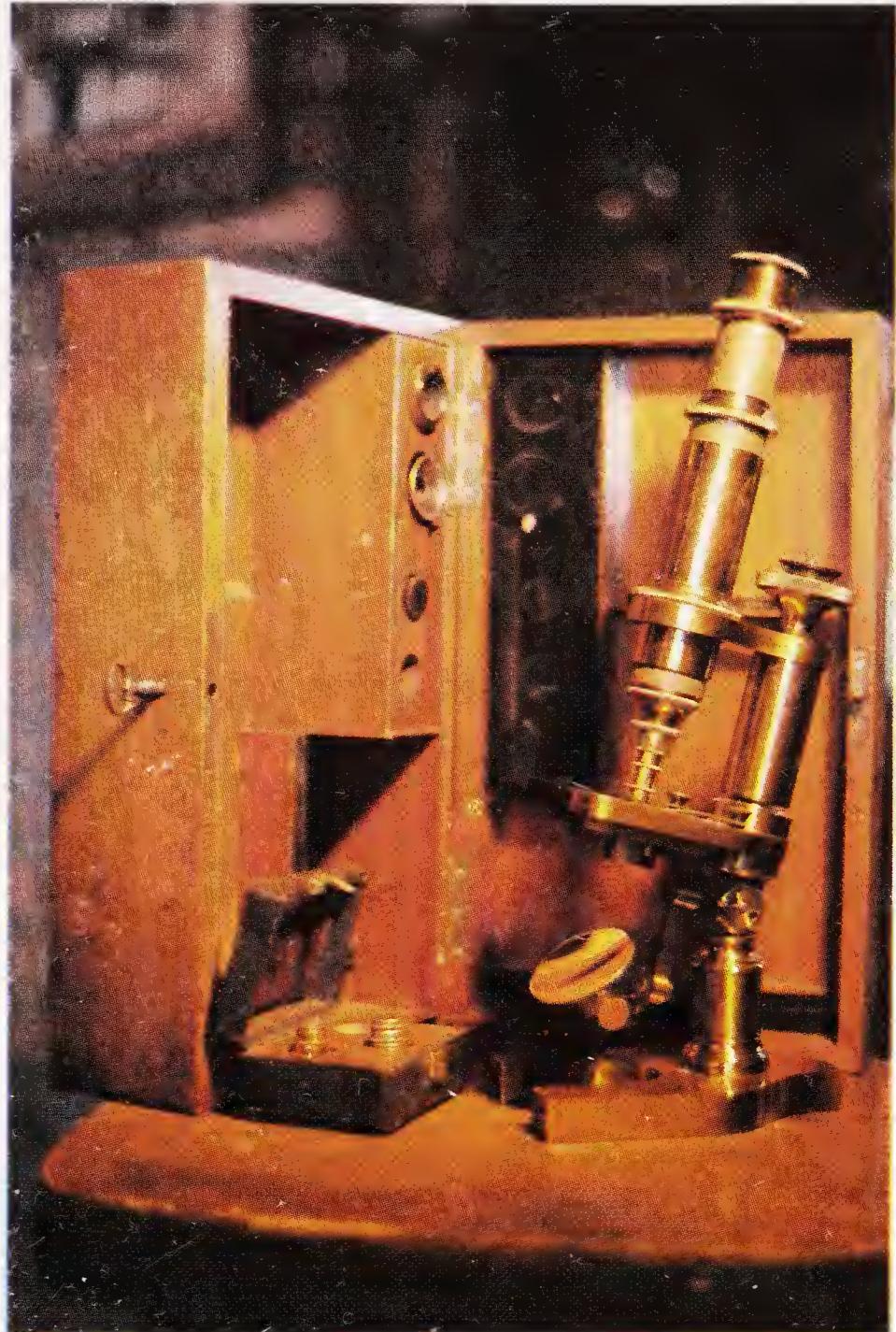
Bring your slide into focus by moving up and away from your slide. Never move the barrel down while you are looking through the eyepiece. If you do, you might smash what you are trying to see.

Get the lens as close as possible to the slide without touching. Then look and get a focus by moving up and away. This saves cleaning or damaging the

lens and smashing the slide and whatever is on it.

Some microscopes are built to stop at a limit point. This keeps the objective lens from getting close enough to break anything.

But it is still a good idea to focus while moving the barrel upward. Then, little adjustments can be made to clear up the image.



Microscope with its case and lenses (left). With the double microscope (above) a teacher can help the student learn how to use a microscope.

School microscopes are usually sturdy and easy to operate. More detailed microscopes are intended for use by trained scientists.



Solar telescope at Kitt Peak Observatory, near Tucson, Arizona is used to study and photograph the sun.

TELESCOPE LENSES

In a telescope, the lenses must be combined in a certain way.

A telescope has an objective lens and an eyepiece lens. So does a

microscope. How are they different?

The objective lens of a telescope points to an object far away.

The eyepiece lens is for looking through.

The objective lens is convex, but just barely. That means it is only curved slightly. It is just a bit thicker in the middle than at the edges.

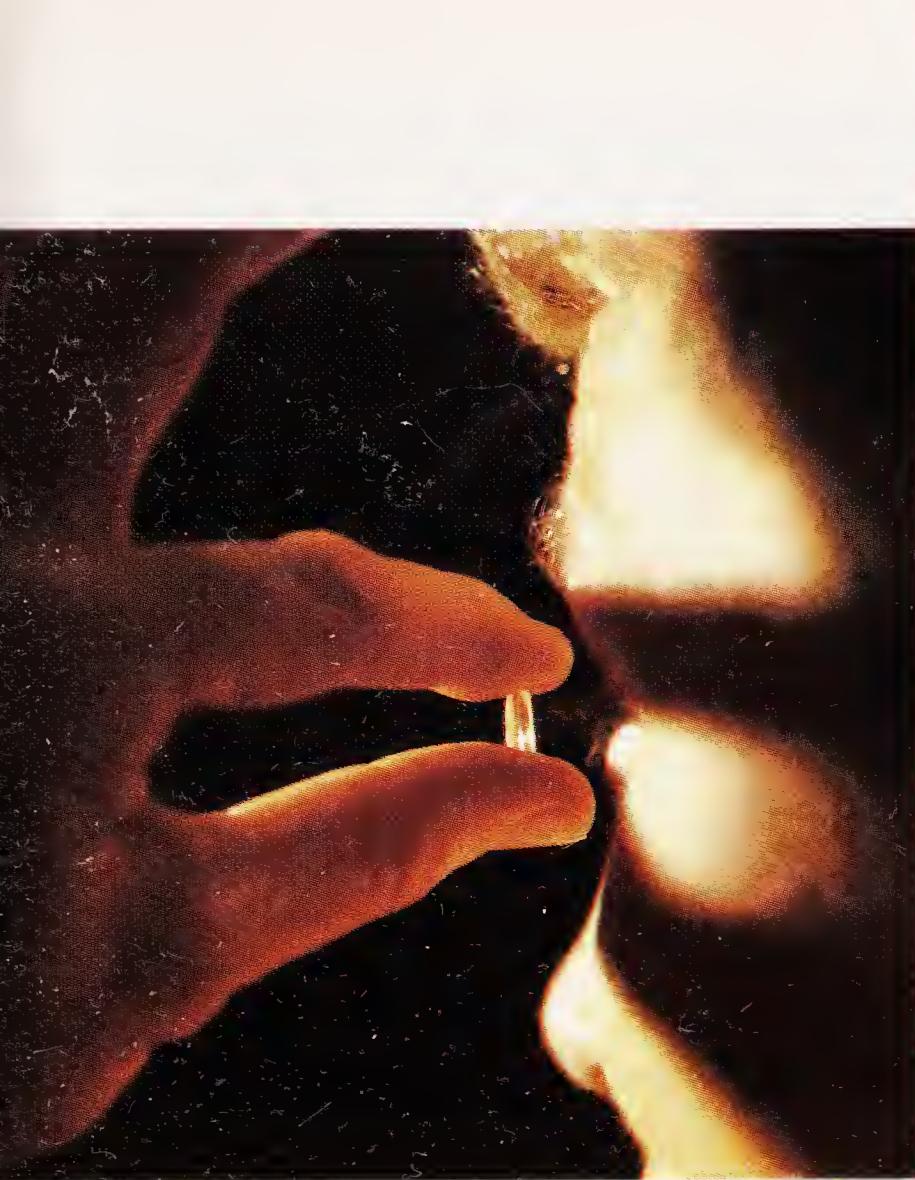
The lens has a focus point that is far from the lens.

The eyepiece lens will have a very short focal length.

The two different lenses must be used to look at something far away.

Hold the short one in front of your eye. What you see will be blurry. Move the long focal length lens slowly away until an image comes into view.

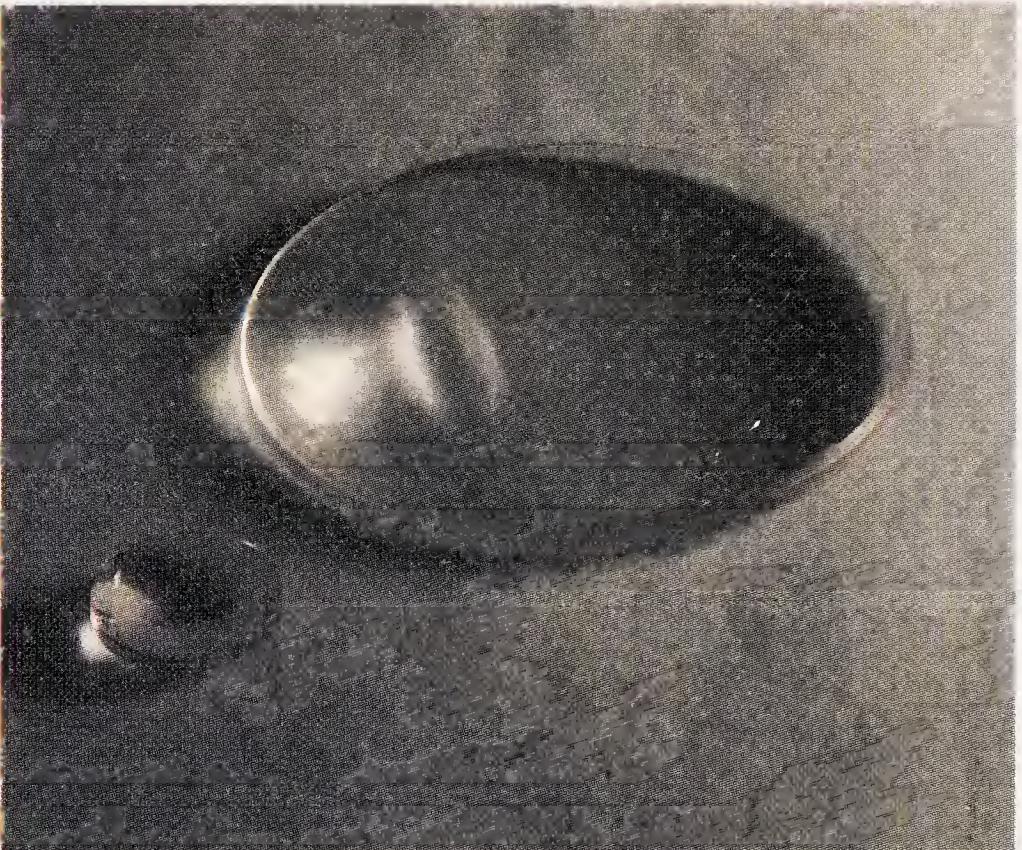
Presto, you will see a fairly clear and large “picture” of the faraway scene. Upside down!



The short focal length lens at the eye (left) is like the eyepiece of a telescope. When paired with a long focal lens (right) you will see faraway objects upside down.

The two lenses will work in combination only at a certain separation.

The tube of a telescope slides a bit in and out, or “telescopes,” to adjust for a clear focus.



In order to work, telescopes must have a smaller short focal lens and a larger object lens.

TYPES OF TELESCOPES

The spyglass adds another lens in the eyepiece part that is exactly like the eyepiece lens. It turns the image

right side up. Lenses do flip flops.

The spyglass magnifies twenty-five times. That is a fairly good magnification.

Another type of telescope can be mounted on a stand so that it moves very little while you look through it.

This type might have prisms inside that act like mirrors for the path of light through the scope. It keeps

the length shorter so it does not need to “telescope” in and out. The light is traveling a much greater distance through the scope than it appears to be.

Another kind of telescope that does not magnify as greatly uses an objective lens, a thin convex lens with a long focal length. But instead of another little convex lens, it uses a concave eyepiece



Binoculars magnify images right side up.

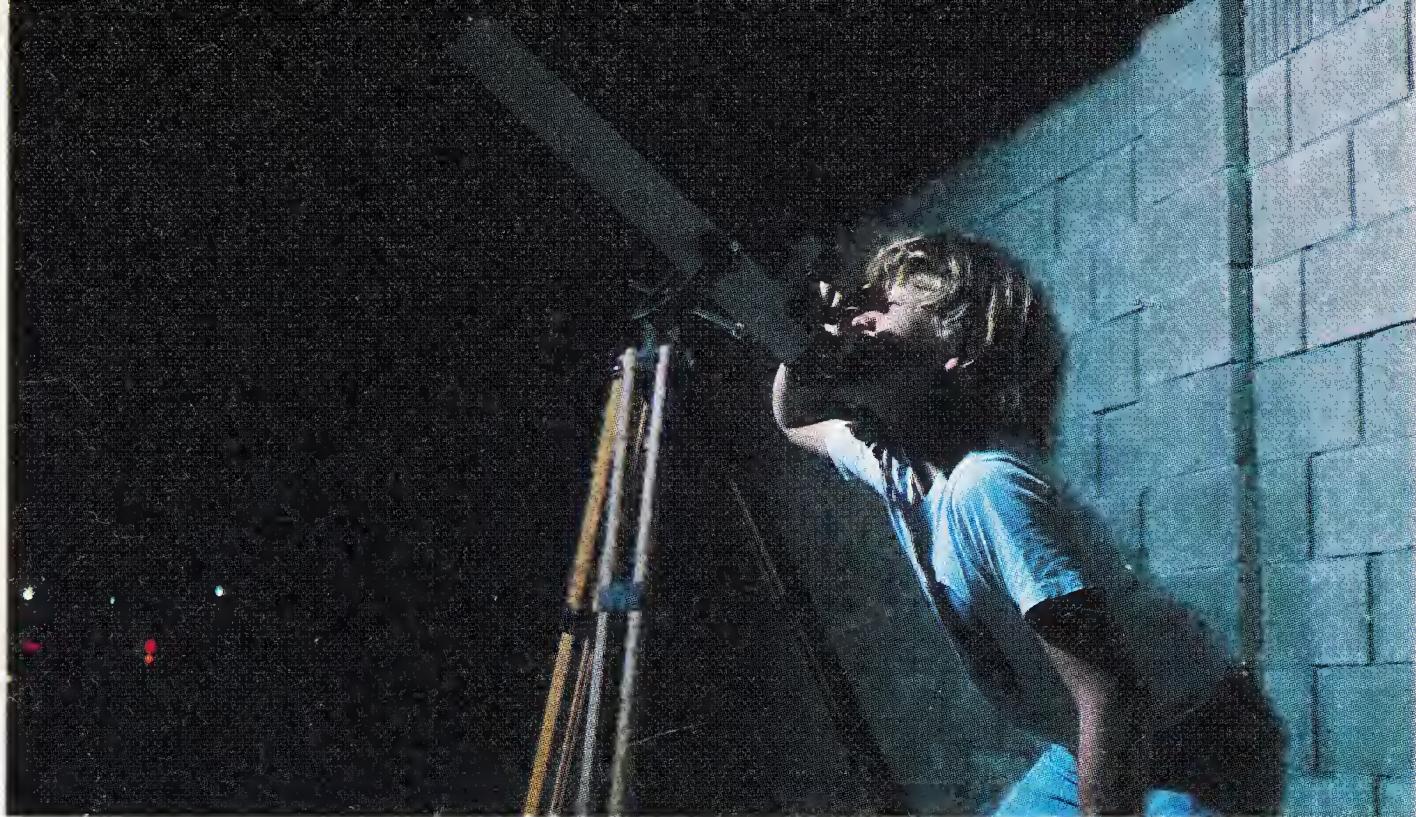
lens. This arrangement gives a right-side-up image. It is used in binoculars. This means two oculars or eyepieces.

Sometimes a monocular scope has one such lens.

TELESCOPE MAGNIFICATION

An astronomical refractor-type telescope on a tripod stand may have a set of different eyepieces, depending on whether you want high or low power magnification.

A long-focus objective lens may need ten inches to focus an image. The eyepiece may focus at two



Telescopes are used to study the stars.

inches. Ten divided by two is five—and that is the magnification power—5X.

The telescope that Galileo used was about 6X. It magnified about the same as binoculars used for watching birds or football games.

A telescope's objective lens may be marked 700 millimeters. The eyepiece ocular may be marked 7 millimeters. Seven hundred divided by seven is one hundred, or 100X for that set of lenses. We get higher powers with a shorter focal length eyepiece. Lower powers use a longer focus eyepiece.



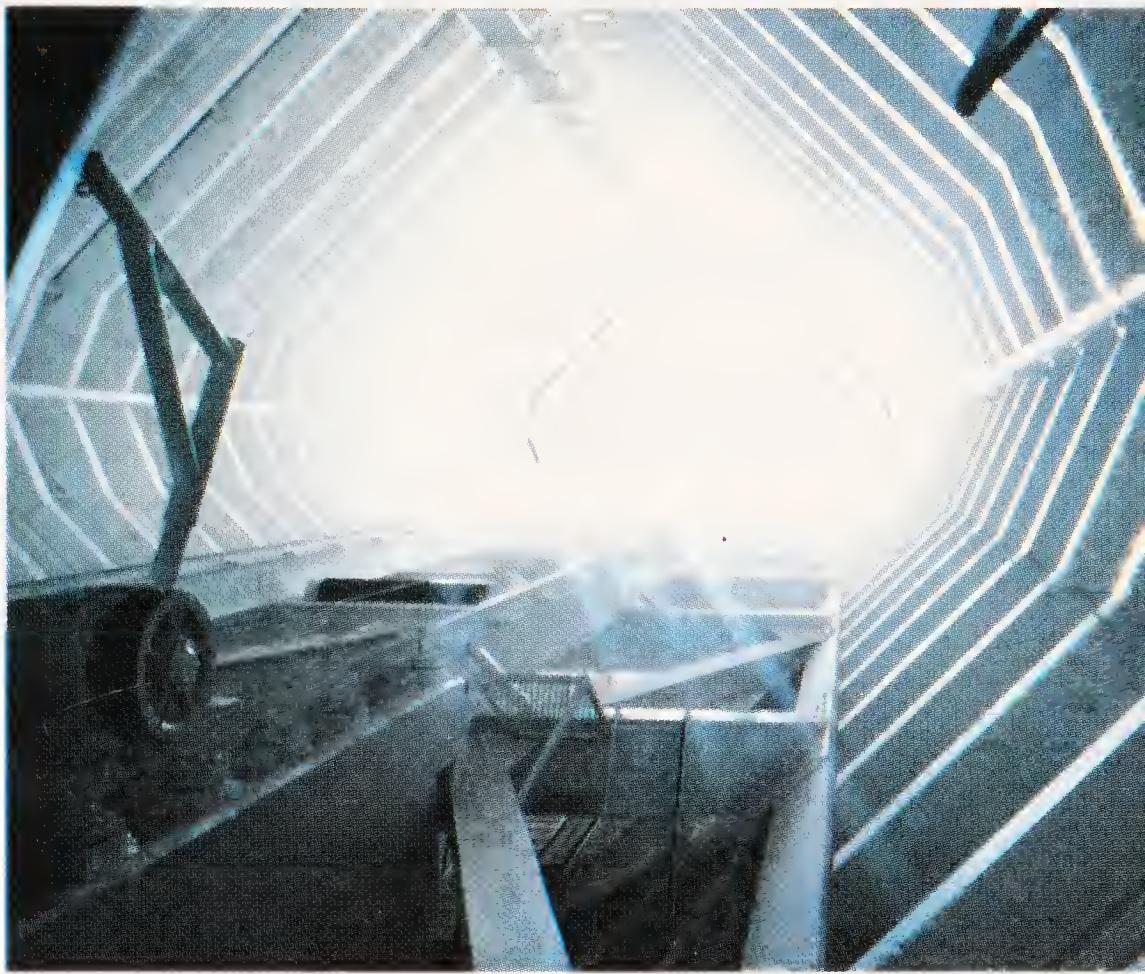
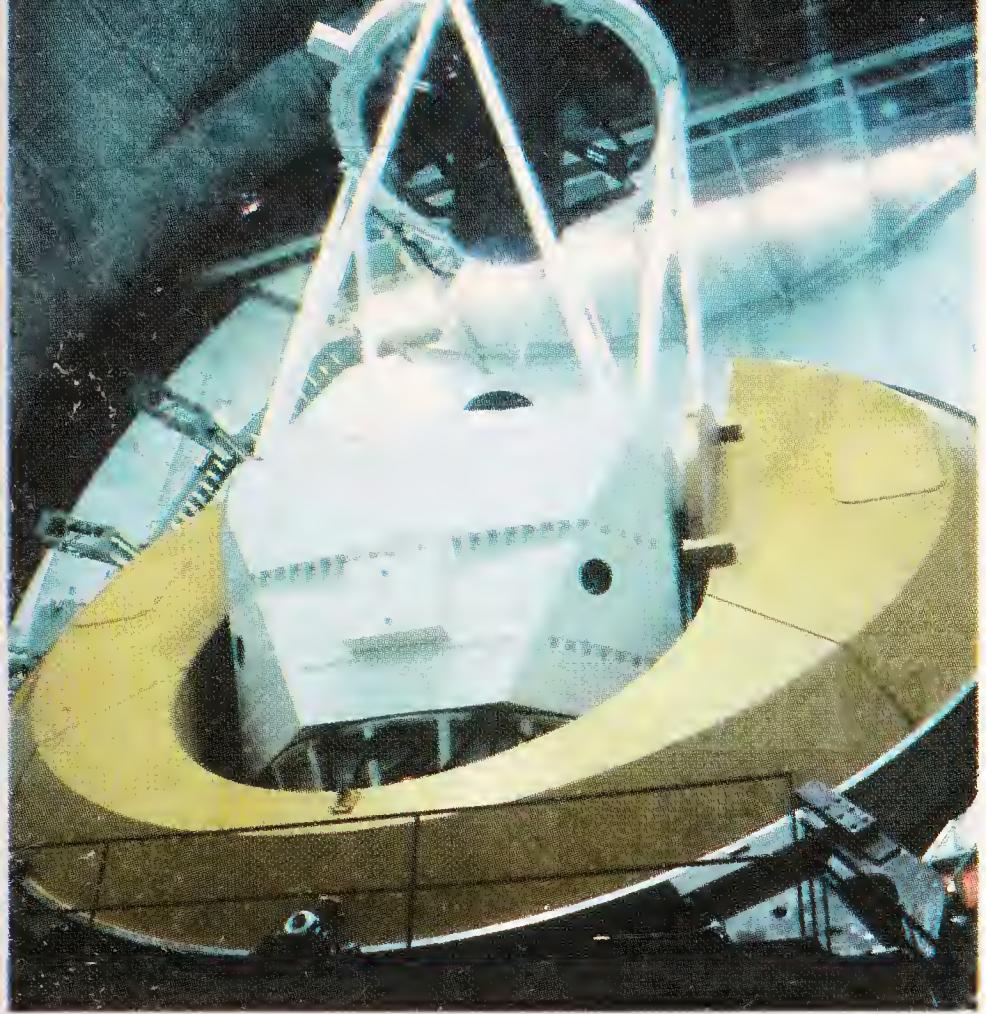
Each type of telescope lens will focus light differently.

REFLECTING TELESCOPES

A round, slightly concave mirror in a telescope reflects light back to a focus. Another mirror can bounce light to one side and out of the tube to an eyepiece lens.

Very large mirrors gather a great deal of light from very faint stars. Focusing on a film, the image can be photographed for study.

The Palomar telescope in California has a 200-inch mirror. It has charted the heavens and discovered many light sources very far away.



Outside view and looking from the inside of the solar telescope at Kitt Peak Observatory near Tucson, Arizona.

AIDS TO THE EYE

The eye is marvelous,
but it has limits.
Microscopes and
telescopes help us see
things our eyes alone
never could see.

WORDS YOU SHOULD KNOW

binocular(by • NOCK • yoo • ler)—a device with two eyepieces used to view objects

command(kuh • MAND)—to direct; be in charge or control

concave(KAHN • kaive)—curved inward

convex(KAHN • vex)—curved outward

curvature(KER • vah • cher)—to be curved

focal length(FOE • kil • LENGTH)—the distance between a lens and where the light waves meet after leaving the lens

focus(FOE • kuss)—the point where rays of light meet after being bent by a lens

image(IM • ij)—the picture formed by light shining through a lens

lens(LENZ)—a piece of clear material that has been shaped to cause light rays that pass through it to meet or spread out

magnify(MAG • nih • fye)—to make an object appear larger

magnifier(MAG • nih • fire)—an instrument that makes objects appear larger

microscope(MIKE • roh • skoap)—an instrument that makes a very small thing look larger

monocular(mon • OCK • yoo • ler)—a device with one eyepiece used to view objects

objective(ob • JEK • tiv)—the part of the microscope, the lens, that first receives the light rays from the object to be viewed

ocular(OCK • yoo • ler)—the eye piece of a microscope

prism(PRIH • zim)—a transparent solid object in the shape of a triangle that bends light

reflect(re • FLEKT)—to throw back light rays that strike a surface

refract(re • FRAKT)—the bending of light rays as they pass through one substance to another

scope(SKOAP)—a device that you use to view something

telescope(TEL • es • skoap)—a device that makes distant objects appear closer and larger

tripod(TRY • pod)—a stand with three legs

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